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Battelle Columbus Labs, OH

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The results of the study show that the concentration of benzene and cyanides were below their detection limits in all of the streams sampled. Further, the concentrations of phenols were below their detection limit in both the influent and effluent of the treatment plant.

The results of the study also show that the lime and settle treatment practiced at this site removes in excess of 90 percent of the lead, mercury, and zinc. The technique is slightly less effective for copper and cadmium because of their low concentrations in the influent to the treatment plant. Nevertheless, in excess of 70 percent of both copper and cadmium was removed. Because of the extremely low concentrations of antimony, chromium, and nickel in the influent to the treatment plant, the effectiveness of the lime and settle treatment for the removal of these metals could not be evaluated with any degree of confidence.

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CHARACTERIZATION OF PRIORITY POLLUTANTS FROM A SECONDARY LEAD AND BATTERY MANUFACTURING FACILITY

by

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FOREWORD

When energy and material resources are extracted, processed, converted, and used, the related pollutional impacts on our environment and even on our health often require that new and increasingly more efficient pollution control methods be used. The Industrial Environmental Research Laboratory - Cincinnati (IERL-Ci) assists in developing and demonstrating new and improved methodologies that will meet these needs both efficiently and economically.

This report contains an assessment of waterborne emissions from a facility in which secondary lead is produced and lead storage batteries are manufactured. The study has been conducted to provide a better understanding of the sources, nature, and control of emissions from such facilities. Particular attention has been given to the presence and control of the priority pollutants. Further information on this subject may be obtained from the Metals and Inorganic Chemicals Branch, Industrial Pollution Control Division.

David G. Stephan
Director
Industrial Environmental Research Laboratory
Cincinnati

ABSTRACT

A plant site at which secondary lead is produced from old batteries was sampled utilizing the U.S. EPA protocol for the priority pollutants. The waste treatment plant at this site uses lime and settle techniques to remove pollutants from the wastewater before it is discharged into a stream.

The results of the study show that the concentrations of benzene and cyanides were below their detection limits in all of the streams sampled. Further, the concentrations of phenols were below their detection limit in both the influent and effluent of the treatment plant.

The results of the study also show that the lime and settle treatment practiced at this site removes in excess of 90 percent of the lead, mercury, and zinc. The technique is slightly less effective for copper and cadmium because of their low concentrations in the influent to the treatment plant. Nevertheless, in excess of 70 percent of both copper and cadmium was removed. Because of the extremely low concentrations of antimony, chromium, and nickel in the influent to the treatment plant, the effectiveness of the lime and settle treatment for the removal of these metals could not be evaluated with any degree of confidence.

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SECTION 1

INTRODUCTION

The Effluent Guidelines Division (EGD), Office of Water Planning and Standards, of the U.S. Environmental Protection Agency (EPA) has been charged with the responsibility for conducting tests to determine the presence of 129 priority pollutants in wastewater from facilities which manufacture non-ferrous metals. Specifically, the EPA is obligated to identify toxic priority pollutants and the effectiveness of various treatment processes for removing them from wastewaters generated in the various types of smelters and refineries, including secondary lead plants. The EGD is required to review the effectiveness of various technologies and to propose and promulgate effluent limitations.

Battelle's Columbus Laboratories (BCL) undertook the preliminary evaluation of facilities and conducted the sampling and analyses of waste streams at one facility. The data were collected for the Office of Research and Development (ORD) in support of the EGD. The information developed herein is to be used to augment the data base supporting a regulation. These data also will be utilized by the ORD to substantiate a metals precipitation manual which is under preparation. Plant operating data are to be used to qualify the performance of the system and to identify factors influencing the characteristics of the samples collected. The activity for this task deals with wastewater discharges from a facility in which secondary lead smelting and battery manufacturing are conducted.

This report describes the process, the wastewater treatment facility, and the sampling and analytical protocol, and presents the results and conclusions. The conclusions are based on the sampling program, which showed how effective the wastewater treatment was in removing not only the 129 priority pollutants, but also those tentatively listed as pollutant parameters in effluent guidelines for secondary lead plants.

SECTION 2

SUMMARY

A plant site, at which secondary lead is manufactured from old batteries, including battery cracking, was sampled using EPA protocol procedures for the priority pollutants.[1] The plant uses a lime and settle wastewater treatment before discharging to a stream. This same plant is used to treat wastewater from the manufacture of industrial batteries, automotive batteries, and lead oxide. All of the waste streams discharging into the treatment plant were sampled (according to protocol) upstream at sumps serving the facilities. The influent as well as the effluent of the wastewater treatment plant was sampled over a 46-hour period. The samples were analyzed for the priority pollutants.

Of the priority pollutants, it was determined that the concentrations of benzene and cyanide were below their detection limits in all of the streams sampled. The concentration of phenol also was determined to be below the detection limit in the influent and effluent water of the treatment plant.

The daily waste loads calculated for the priority pollutants and the efficiencies of their removal are shown in Table 1.

TABLE 1. EFFICIENCY OF THE REMOVAL OF METALS FROM WASTEWATER PRODUCED IN A SECONDARY LEAD AND BATTERY PLANT

Priority Pollutant	Influent Load, kg/day	Influent Concentration, mg/ℓ	Effluent Load, kg/day	Effluent Concentration, mg/ℓ	Removal Efficiency, %
Copper (Cu)	0.250	0.16	0.062	0.04	75.0
Zinc (Zn)	0.960	0.58	0.078	0.05	91.0
Lead (Pb)	3.907	11.70	0.202	0.27	95.0
Antimony (Sb)	1.250	0.80	1.383	0.89	--
Cadmium (Cd)	0.172	0.11	0.047	0.03	73.0
Chromium (Cr)	0.141	0.09	0.140	0.09	0.7
Nickel (Ni)	0.219	0.14	0.233	0.15	--
Mercury (Hg)	0.001	0.66	--	<0.02	100.0

Based on these results, it is concluded that the lime and settle treatment

as practiced in this facility is very effective in removing zinc, lead, and mercury and slightly less effective for copper and cadmium because of the low concentrations encountered. The effectiveness of this method in removing nickel, chromium, and antimony could not be evaluated with confidence because the low concentrations in the influent to the treatment plant are probably near solubility limits at pH 8.5.

SECTION 3

SOURCE DESCRIPTION

PROCESS DESCRIPTION

At the plant site, lead compounds, lead, and lead alloys from secondary sources are smelted and refined. In addition, lead oxide and automotive and industrial batteries are manufactured on site. The plant consists of the following areas:

- blast furnaces to melt or reduce the lead or lead oxide scrap,
- a reverberatory furnace in which lead scrap is melted and refined,
- a baghouse and lime-water scrubber serving the furnaces,
- a continuous casting line for ingots,
- a large receiving yard where the materials for charging the blast furnace (i.e., coke, scrap iron, rerun slag, reverb slag, limestone, plastic battery cases, antimony ore and dross, flue dust and scrap, and lead battery plates) are stored mainly under roof,
- battery breaking operations,
- industrial battery manufacturing operations,
- automobile battery manufacturing operations,
- lead oxide manufacturing operations,
- a wastewater treatment plant, and
- a landfill.

The relationship of each area of operation to the wastewater load to the treatment plant is shown in Figure 1.

The blast furnace, reverberatory furnace, and ingot line noncontact cooling water discharge into a sump which also is used to gather roof and plant runoff for treatment.

Used batteries containing spent electrolyte (sulfuric acid, etc.) are processed on site. The tops of batteries are sheared off and contents dumped. The lead and lead compounds are separated from the electrolyte which is mixed with wash water. This wastewater is a major effluent. It is pre-treated by settling before being pumped to the treatment plant from the sump serving this facility.

In the manufacture of industrial and automobile batteries, wastewater is

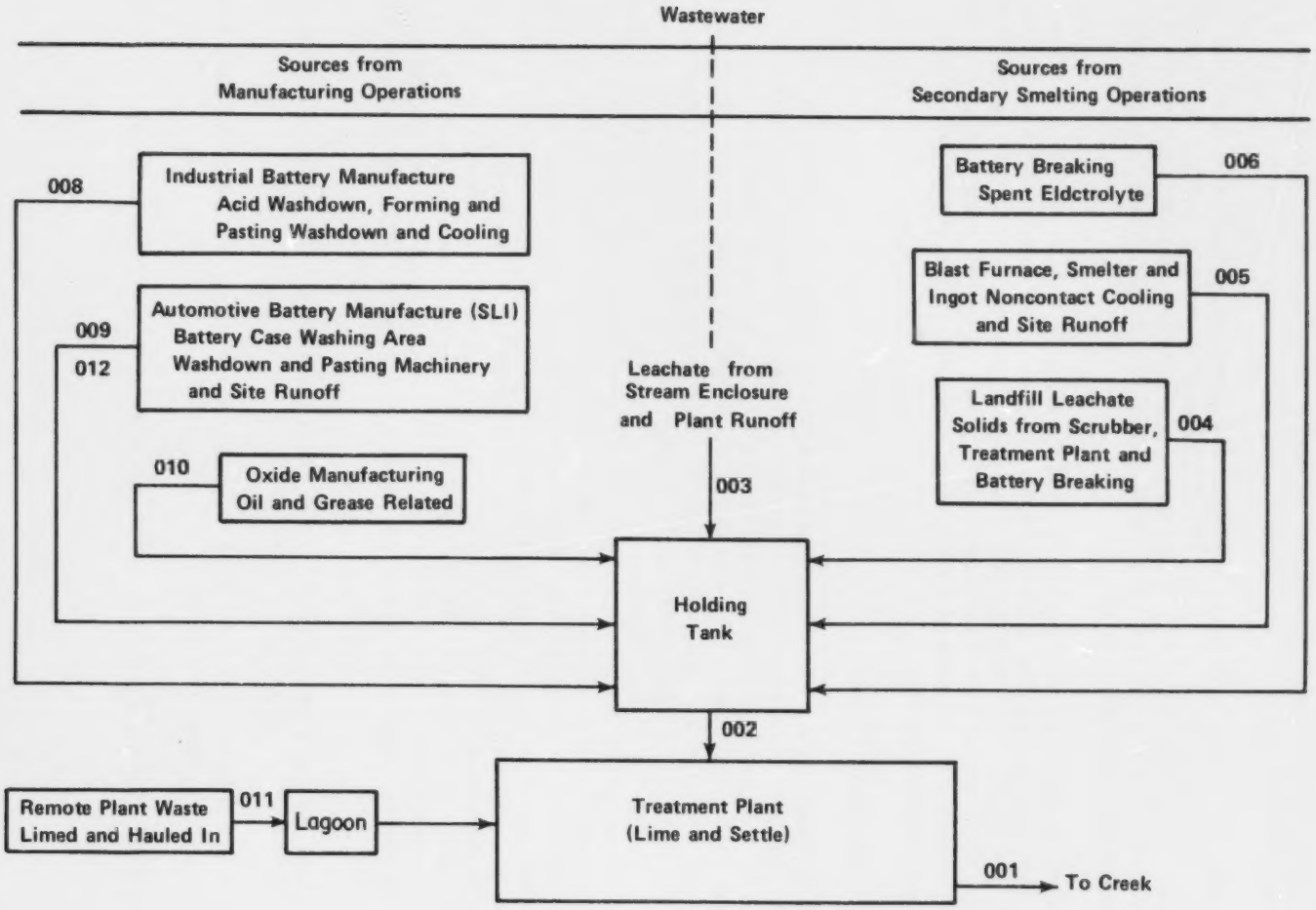

FIGURE 1. SOURCES AND SAMPLE CODE FOR WASTEWATER STREAMS

(Secondary Lead-Battery Manufacture Mix)

generated from the washdown of sulfuric acid spills that occur during battery filling and the washdown of the stations where lead oxide pasting and forming are done. Contact cooling wastewater from the manufacture of lead oxide contains oil and grease.

Although the blast and reverberatory furnaces emissions are scrubbed with lime water, the wastewater is recycled. The solids formed during the scrubbing are disposed of in the landfill along with the solids produced during wastewater treatment. The leachate from this landfill is collected and contributes to the wastewater treatment load.

In order to prevent any leachate originating from the plant area from polluting the stream passing under the plant site, the leachate is collected outside an enclosure surrounding the stream and pumped to the wastewater treatment plant. The wastewater treatment plant also receives pretreated (limed) wastewater brought in by tanker truck from a nearby plant where automobile batteries are manufactured.

WASTEWATER TREATMENT PLANT

The treatment plant receives wastewater from eight collection sumps located throughout the plant in four holding tanks, as shown in Figure 2. The wastewater is pumped from the holding tanks to the primary reaction tank where it is mixed with dry lime. The slurry is then gravity fed to the secondary reaction tank where a 0.1 percent solution of flocculating agent (CALGON Wt-3000) is added at a rate of about 3.8 ℓ/min (1 gal/min) to promote flocculation and crystal growth. The wastewater is sent on to two clarifiers and the clarifier overflow enters a series of three lagoons for settling before being discharged to the stream. The pH of the discharge from the treatment plant is 7 to 8.5. The underflow from the clarifiers is pumped to a thickener where further separation of liquid and solid occurs. The underflow, containing about five percent solids, is trucked to the landfill. The overflow from the thickener is returned to the secondary reaction tank via a receiving lagoon. This lagoon also receives the limed wastewater brought from a plant in a nearby city four times a day (about 5000 gallons per load). The underflow from the receiving lagoon is recycled to the thickener. All the lagoons are cement lined.

The limed wastewater received from the remote plant contains Thrifty Foam* and Duponal† as well as excess lime.

About 1550 m^3/day (410,000 gpd) of wastewater from the holding tanks was treated during the sampling period.

Plant production during the sampling period appears on page 8.

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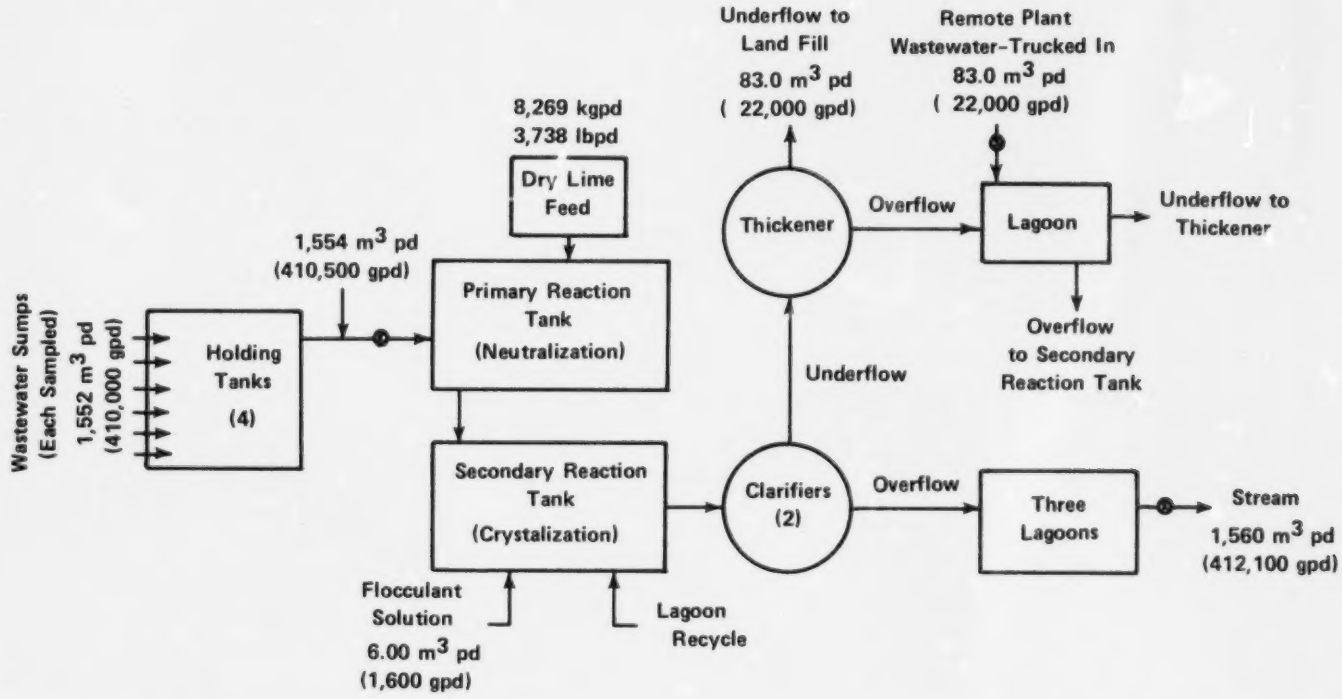
* DuBois Chemical Company, Sharonville, Ohio.
† E. I. DuPont, Dye and Chemical, Wilmington, Delaware.



Influent = 410,500 + 1,600 + 22,000 = 434,100
Effluent = 412,100 + 22,000 = 434,100

FIGURE 2. DIAGRAM OF WASTEWATER FLOW IN A WASTEWATER TREATMENT PLANT FOR A SECONDARY LEAD-BATTERY MANUFACTURE FACILITY

(⊗: Sampling Sites; See Figure 1 for Greater Detail)

Plant production during the sampling period:

Industrial Batteries*

41.2 kkg/day
(37.4 tons/day)

Oxide Production

44 kkg/day
(40 tons/day)

Lead Smelter

198 kkg/day
(180 tons/day)

On-Site Auto Battery Manufacturing

~6,540 batteries/day

Remote Auto Battery Manufacturing

~7,500 batteries/day

* Industrial battery production is designated by weight rather than number because of the variability in their size.

SECTION 4

SAMPLING AND ANALYTICAL APPROACH FOR VERIFICATION TESTING OF PRIORITY POLLUTANTS

An approach was developed which is used for sampling and analysis for verification testing to determine the presence or absence of priority pollutants in wastewater discharges from a secondary lead smelting plant. Waste streams before commingling at the treatment plant, as well as the commingled influent and effluent, were sampled because of the mix of the smelting operation waste streams with battery manufacture waste streams. Five streams related to smelting operations were sampled according to the protocol for the priority pollutants. Five additional streams from battery manufacture were also sampled. Samples were also analyzed for total suspended solids, metals (As, Cd, and Pb), sulfates, and oil and grease.

The precautions taken to meet stringent quality assurance guidelines in the sampling procedure, field flow measurements, and analytical procedures (i.e., sampling and analytical protocol) are described in this section of the report.

SAMPLING PROCEDURES

Presampling Preparation

All presampling activity was directed at assembling, cleaning, and storing sample containers to be used in the field according to the procedures outlined in "Appendix III, Collection of Samples for Screening Analysis, of the Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants."[1] Sample containers were cleaned, rinsed with organic-free water, drained and air- or oven-dried at 100°C as appropriate.

Sampling Sites

During an initial survey of the plant, sampling sites were identified. The sampling points were located at the influent to the treatment plant (between the holding tanks and the primary reaction tank) and at the effluent being discharged from the last lagoon. Upstream sampling points were sumps receiving the wastewater from the industrial operations noted in Figure 1. The sampling sites and the coding used in the field to identify the samples and record information on the progress of the sampling in a permanent record book* are given in Figure 1. The only difference between the presampling

* BCL Notebook 33888.

survey sites and the final sites sampled was the addition of a sump which collects battery case washings in the automotive battery manufacturing area (012). Organic-free "blank" water supplied by BCL was identified as 000 and the source water at the site as 007 (city water).

Collection Techniques

Three areas assumed to be critical in the overall wastewater collection and treatment facility were sampled in duplicate composites:

- The influent to the treatment plant (002) was composited over a 46-hour period by a constant drip rate method (∿3 mℓ/min) and also manually. The manual collection took place every 2 hours using a 600-mℓ beaker filled to 400 mℓ. Both composites were collected in 10,000-mℓ bottles (Pyrex) kept at ice temperature.

- Two 10,000-mℓ composites of treatment plant effluent (001) were collected in a 46-hour period. One was collected with an ISCO* automatic sampler taking constant volume samples every 20 minutes, and the other was collected manually every 2 hours using a beaker, as described above. Again, all samples were kept iced during and after the sampling period.

- Two composites of the battery breaker sump (006) also were prepared. One was prepared with the ISCO sampler and the other manually.

In those cases were the ISCO unit was used, it was given a field "blank" water treatment and an operational sampling using "blank" water.

Samples from the remaining process wastewater sumps were composited during the 46-hour sampling period manually using beakers to remove the 500-mℓ samples from the sump. Each site had its own sampling beaker and each beaker was protected from dust and dirt between sampling periods. All were kept at ice temperature during and after sampling (ambient air was near freezing).

Grab samples for phenol, cyanide, and organics were taken once between 1500 and 1600 hours, when maximum production activity was evident, and again at low plant activity at 2100 and 2330 hours:

- Each sample for cyanide analysis was collected in a 1-liter amber polyethylene bottle and preserved with 0.6 gram of ascorbic acid and at least 2 mℓ of 10N NaOH; final pH = 10.

* ISCO = Model 1680, ISCO, Lincoln, Nebraska.

- Each sample for phenol was collected in a 1-liter glass bottle and preserved with 2 mℓ H_2SO_4 (conc.), if pH was greater than 4.

- Samples for benzene (organics) were collected in an 8-oz glass bottle with extra precautions taken during filling to eliminate entrapped air bubbles at the Teflon/silicone septa cap.

- Each set of grab samples had its own "blank" water sample prepared.

All sampling events were recorded in a permanent record book and specially prepared labels were marked with waterproof markers and affixed with waterproof tape. A log of the 71 daily grab samples and eighteen 10-liter composites was prepared and is appended to this report.

Sample Shipping

The collected samples were kept at ice temperature while being transported from the plant site to BCL by truck (overnight). Once at BCL, the samples were stored in a cooler set at 4°C until split (a period of 2.5 days during the weekend).

Sample Splitting

The composited samples were split according the recommendations cited in the "Collections of Samples for Screening Analyses of Priority Pollutants"[1]; that is, by syphoning into five clean bottles after magnetic stirring of the composite using a Teflon stirring bar. Polyethylene tubing equipped with a Viton rubber tip was used to make the transfers. The system was washed thoroughly and rinsed with "blank" water between uses. The bottles were cleaned using 1N HNO_3 and at least triple rinsed with "blank" water (Milli-Q-water), drained, heated to 200°C, and cooled in a dust-free area to room temperature. Caps also were cleaned and lined with close-fitting Teflon liners. The bottles were labeled and coded in sets of five (one 16-oz bottle and four 32-oz bottles), to match the composite being split. The five samples were to be used for the following purposes and were identified as such:

- Metals (MET)
- Pesticides, PCB, and asbestos (P&P)
- Gas chromatography/mass spectroscopy (GC/MS)
- Classic parameters (CP)
- Company's sample.

The remainder of the composite was stored at 4°C for further use if needed.

In each case, the composites selected for splitting were all manually composited samples. The composites prepared by automatic sampling were reserved as backup and stored at 4°C without splitting. This approach provided an opportunity for comparison of similarly collected composites if needed.

The coding used to identify the split samples matched that used to identify the streams sampled in the field (i.e., 000 through 012).

All of the samples split from the composite were stored at 4°C until their submission for analysis. Custody of these samples was transferred formally to the analytical team with a list of their identity, origin, and analyses required.

Probable Qualifications Regarding Sampling

(1) The failure of the automatic samplers to perform uniformly in the field made the composite less likely to be representative than the manually composited samples. The failure was caused by collapse of the thin-walled Teflon tubing supplied with the unit. If it had not been for the precaution of parallel manual sampling, the quantity of sample collected would have fallen short of that required for samples.

(2) A 28-hour composite from the battery case wash and rinse water stream (automotive battery production, 012) was collected since this sump was not discovered until 18 hours into the sampling period. However, since the flow of this stream was steady rather than intermittent, the 28-hour composite is believed to be comparable to a 46-hour composite.

FLOW MEASUREMENT

Both the flow rate of the effluent from the treatment plant and the influent from the holding tanks are measured through a weir and recorded in the control room of the treatment plant. The wastewater from the sumps is discharged via pumps (usually in pairs) to the holding tanks. For pumps equipped with on-time clocks, the amount of flow from the sumps was calculated from their capacity and their period of operation. Those without clocks were equipped with electric clocks by the sampling team and plant personnel before the sampling was started to provide measure of on-time. One weakness in this method is that the capacity of the pump is given against a fixed hydrostatic head which may or may not be the head it is working against. In this case the estimations of flows were reasonably accurate.

Flow rates for the sampling period for each of the wastewater streams sampled are given in Table 2. A water balance for the sampling period is presented in Table 3. Based on the estimates made from the pump capacity and the pump clock on-time, the value for volume of the wastewater pumped to the holding tanks from the sumps per day agrees very well with the volume entering the treatment plant from the holding tanks. The volume used for waste load calculations was 1550 m^3/day (409,500 gpd). The volume of source process water was slightly less than that calculated as pumped from the sumps from operations known to use process water directly, but the difference was not considered significant. In order to bring the flows near balance it was

TABLE 2. DAILY FLOW RATES FOR SECONDARY LEAD-BATTERY MANUFACTURE MIX

Wastewater Stream Code	Process	Method of Measurement	24-Hour Flow Rate m^3/day (gpd)
001	Treatment Plant Effluent	Weir-Meter Readings	1563.00 (412,850)
002	Treatment Plant Influent	Weir-Recorded Continuously	1554.00 (410,580)
003	Stream Enclosure Leachate	Pump Capacity/ On-Time Clock	75.44 (19,930)
004	Landfill Leachate	Pump Capacity/ On-Time Clock	197.46 (52,170)
005	Furnace Noncontact Cooling	Pump Capacity/ On-Time Clock	138.72 (36,650)
006	Battery Breaker	Pump Capacity/ On-Time Clock	69.83 (18,450)
007	Process Water	Meter Reading[a] for Period	1040.88 (275,000)[a]
008	Industrial Battery Manufacturing	Pump Capacity/ On-Time Clock	306.59 (81,000)
009	Automotive Battery Manufacturing Site Leachate and Runoff	Pump Capacity/ On-Time Clock	190.27 (50,270)
010	Lead Oxide Production	Pump Capacity/ On-Time Clock	286.15 (75,600)
011	Remote Plant Trucked In Wastewater	Weight of Load[b]	83.45 (22,050)
012	Automotive Battery Manufacturing Wash and Rinse	Pump Capacity/ On-Time Clock	287.05 (75,840)

(a) Usage measurement for period by plant.
(b) The volume of load was estimated from the weight of the load and the specific gravity of the liquid (assuming the same specific gravity as that of H_2O).

TABLE 3. WATER BALANCE DURING SAMPLING PERIOD
SECONDARY LEAD-BATTERY MANUFACTURE MIX

Daily flow to holding tanks during sampling period:	
Σ 003, 004, 005, 006, 008, 009, 010, 012	≅ 1550 m^3/day (409,500 gpd)
Influent, 002, to treatment plant	= 1550 m^3/day (409,500 gpd)
Daily wastewater flow related to process source water flow during sampling period:	
Wastewater Σ 005, 006 less electrolyte, 008, 010, 012	= 1380 m^3/day (372,540 gpd)
Source water, 007 plant data[a]	= 1041 m^3/day (275,000 gpd)

(a) Metered water only.

necessary to correct the wastewater flow from the battery breaking operation, Sample 006, for the volume of spent electrolyte introduced into the system. This amount was estimated to be about 1.9 liters per battery for the approximately 8000 batteries processed per day during the sampling period.

ANALYTICAL PROCEDURE

Only those priority pollutants specific to the secondary lead/antimony segment of the nonferrous metals category were determined in accordance with the work plan. These were handled as follows:

Collect, Analyze, and Preserve Samples	Collect and Preserve Sample Only
Antimony (Sb)	Asbestos, pesticides
Cadmium (Cd)	Dimethyl phthalate
Chromium (Cr)	Diethyl phthalate
Copper (Cu)	Di-n-butyl phthalate
Cyanides (CN^-)	Bis (2-ethyl hexyl) phthalate
Lead (Pb)	Butyl benzyl phthalate
Mercury (Hg)	
Nickel (Ni)	
Zinc (Zn)	
Phenols	
Benzene	

In addition to those waste streams related to secondary lead production, analyses for priority pollutants also were made of the wastewaters generated in industrial battery manufacturing, automotive battery manufacturing, and lead oxide production. These streams were also analyzed for oil and grease.

All the wastewater streams also were analyzed for pH, total suspended solids (TSS), sulfate, and other pollutant parameters related to secondary lead manufacture.

The analytical results are summarized in Table 4. The sample numbers in Table 4 are the base numbers recorded in Battelle Record Book No. 33888 (see section on sample splitting). Quality assurance information for the data in Table 4 for oil and grease, benzene, total cyanide, soluble sulfate, and phenols is summarized in Table 5. Similar information for trichloroethylene and metals is presented in detail.

Trichloroethylene

Because a chromatographic peak can be the result of one or more compounds, confirmation analysis by mass spectrometry was needed to positively identify these peaks which were identified as benzene by retention time. The first confirmation was run on Sample 007 which comes from the city water supply. Treating the process water in a manner sensitive enough to detect 78 ng of benzene by mass spectrometry, only a trace was detected. However, a very strong pattern of trichloroethylene was present. (It is not uncommon to find chlorinated hydrocarbons in water supplies that have been chlorinated.)

Mass spectrometer confirmation analysis on Samples 002, 003, and 010 showed they all contained trichloroethylene as the major component and only a trace of benzene (<0.1 ppb). Since the source of the trichloroethylene was the city water supply and all other samples not yet confirmed showed lesser amounts, it was not believed to be necessary to confirm the other samples, except for Sample 011 whose origin was another plant site. This sample also contained trichloroethylene but no benzene. A trichloroethylene standard was run and used to calculate the values for trichloroethylene reported in Table 4.

Sample 003, which contained the highest amount of trichloroethylene, was run in triplicate with the following results: 63.1 µg/ℓ, 57.3 µg/ℓ, and 55.0 µg/ℓ. The maximum deviation from the average was 4.6 µg/ℓ or about 8 percent from the average. Sample 007 gave values of 6.29 and 6.60 µg/ℓ which averages 6.45 µg/ℓ, or about 2.4 percent deviation from the average. Duplicate analyses on Sample 001 gave values of 6.1 and 6.5 µg/ℓ.

Metals

A Perkin Elmer Model 305B atomic absorption spectrophotometer was used for the metal analysis. The conventional air-acetylene flame method was used for all metals except mercury. A flameless method was used for the mercury analysis.

The insoluble metals are those that can be filtered from the sample, and the soluble metals remain and are analyzed in the filtrate.

The mercury analyses were done with the flameless cold vapor techniques in which the mercury is reduced, amalgamated onto silver wool, and then released into the absorption cell by heating the silver wool.

TABLE 4. ANALYTICAL SURVEY RESULTS - SECONDARY LEAD-BATTERY MANUFACTURE MIX

Sample No.	Sample Location	Oil&Grease mg/ℓ	Benzene µg/ℓ	Total Cyanide mg/ℓ	Soluble Sulfate mg/mℓ	Suspended Solids mg/ℓ	Phenols µg/ℓ	Soluble Copper mg/ℓ	Insoluble Copper mg/ℓ	Soluble Zinc mg/ℓ	Insoluble Zinc mg/ℓ	Trichloro-ethylene µg/ℓ	pH
000	Blank Water Taken to Site	1.4	<0.1	<0.01	<0.0001	<0.01	<4	<0.01	0.01	.03	<0.01	<0.1	6.4
001	Wastewater Treatment Plant Effluent	-	<0.1	<0.01	3.5	0.01	<4	0.04	<0.01	0.05	0.01	1.8	8.3
002	Wastewater Treatment Plant Influent	-	<0.1	<0.01	4.7	0.05	<4	0.16	<0.01	0.58	<0.01	3.3	1.4
003	Stream Enclosure Leachate	-	<0.1	<0.01	0.68	<0.01	6	0.08	<0.01	0.28	<0.01	59	2.6
004	Landfill Leachate-Smelter Area	-	<0.1	<0.01	3.2	0.08	5	0.20	0.01	0.94	0.02	2.9	4.5
005	Furnace and Ingot Cooling, (no contact)	-	<0.1	<0.01	0.51	0.04	<4	0.01	0.05	0.30	0.05	0.4	6.9
006	Battery Breaker Sump	-	<0.1	<0.01	40.3	0.20	<4	1.8	<0.01	7.6	0.03	2.6	0.6
007	Process Water-City Water	-	<0.1	<0.01	0.05	<0.01	<4	0.01	<0.01	0.10	<0.01	6.5	7.6
008	Industrial Battery Manufacturing	0.7	<0.1	<0.01	5.9	0.05	5	0.14	<0.01	0.20	<0.01	2.9	2.9
009	Auto Battery Manufacturing Area Leachate and Runoff	- <0.1	<0.1	<0.01	0.40	<0.01	<4	0.02	<0.01	0.20	<0.01	1.3	1.4
010	Lead Oxide Manufacturing Plant	21.3	<0.1	<0.01	0.06	0.01	<4	<0.01	<0.01	0.05	<0.01	6.0	7.9
011	Remote Auto Battery Plant	2.1	<0.1	<0.01	1.9	7.6	<4	0.03	0.05	0.06	0.12	6.4	7.5
012	Auto Battery Manufacturing/Washer and Rinse	1.6	<0.1	<0.01	37.2	0.14	33	0.35	<0.01	0.59	<0.01	1.9	0.7

Milligrams per liter (mg/ℓ) = parts per million

Micrograms per liter (µg/ℓ) = parts per billion

Milligrams per milliliter (mg/mℓ) = weight percent x 0.1

(continued)

TABLE 4. (Continued)

Sample No.	Sample Location	Soluble Lead mg/ℓ	Insoluble Lead µg/ℓ	Soluble Antimony mg/ℓ	Insoluble Antimony mg/ℓ	Soluble Cadmium mg/ℓ	Insoluble Cadmium mg/ℓ	Soluble Chromium mg/ℓ	Insoluble Chromium mg/ℓ	Soluble Nickle mg/ℓ	Insoluble Nickle mg/ℓ	Soluble Mercury µg/ℓ	Insoluble Mercury µg/ℓ	pH
000	Blank Water Taken to Site	<0.05	<0.05	<0.33	<0.33	<0.01	<0.01	0.03	<0.01	<0.04	<0.04	<0.2	<0.2	6.4
001	Wastewater Treatment Plant Effluent	0.13	0.14	0.89	<0.33	0.03	<0.01	0.09	<0.31	0.15	<0.04	<0.2	<0.2	8.3
002	Wastewater Treatment Plant Influent	2.5	9.2	0.80	<0.33	0.11	<0.01	0.09	<0.01	0.14	<0.04	<0.2	0.66	1.4
003	Stream Enclosure Leachate	1.8	<0.05	<0.33	<0.33	<0.01	<0.01	0.15	<0.01	0.13	<0.04	<0.2	<0.2	2.6
004	Landfill Leachate Smelter Area	4.5	7.9	0.35	<0.33	0.08	<0.01	0.07	0.02	0.27	<0.04	<0.2	0.56	4.5
005	Furance and to Ingot Cooling, (No Contact)	0.31	3.7	<0.33	<0.33	0.08	<0.01	0.04	<0.01	0.11	<0.04	<0.2	<0.2	6.9
006	Battery Breaker Sump	4.2	88.	18.0	0.41	3.0	<0.01	0.41	0.02	0.94	<0.04	0.42	<0.2	0.6
007	Process Water-City Water	0.16	0.05	<.33	<0.33	<0.01	<0.01	0.03	<0.01	<0.04	<0.04	<0.2	<0.2	7.6
008	Industrial Battery Manufacturing	2.4	4.23	<0.33	<0.33	<0.01	<0.01	0.05	<0.01	<0.04	<0.04	<0.2	4.3	2.9
009	Auto Battery Manufacturing Area Leachate & Runoff	0.87	<.05	<0.33	<0.33	<0.01	<0.01	0.04	<0.01	<0.04	<0.04	<0.2	<0.2	1.4
010	Lead Oxide Manufacturing Area	0.15	1.6	<0.33	<0.33	<0.01	<0.01	0.03	<0.01	<0.04	<0.04	<0.2	<0.2	7.9
011	Remote Auto Battery Plant	0.65	15	<0.33	<0.66	0.02	<0.02	0.05	<0.02	0.12	0.14	<0.2	0.62	7.5
012	Auto Battery Manufacturing Case Washer and Rinse	2.4	3.3	0.43	<0.33	0.02	<0.01	0.83	0.01	0.39	<0.04	<0.2	0.30	0.7

TABLE 5. QUALITY ASSURANCE FOR POLLUTANT ANALYSES

Analysis	Sample	Material Added	Material Found	Recovery, percent
Oil and grease	Standard	1.5 mg oil 2.1 mg grease	3.7 mg	102.7
	Standard	4.8 mg oil 4.2 mg grease	8.9 mg	98.9
	008	7.8 mg oil 4.9 mg grease	11.9 mg	93.7
Benzene	Calibration	1.42 µg	1.36 µg	96
	003	51.4 µg/ℓ	48.0 mg/ℓ	93.4
	007	5.50 µg/ℓ	4.8 µg/ℓ	87.3
Total cyanide	009	2.6 mg/ℓ	2.4 µg/ℓ	92.7
Soluble sulfate	000	48.0 mg/mℓ	47.2 mg/mℓ	98.3
Phenols	000	4.71 µg/ℓ	3.77 µg/ℓ	80
	006	18.8 µg/ℓ	17.0 µg/ℓ	90.4
	009	9.4 µg/ℓ	10.8 µg/ℓ	115

The addition method was used as a cross-check for the direct analysis method for all metals except mercury. In this method, known quantities of the metal being tested are added to aliquots or dilutions of the sample. The absorbance of these solutions and of sample solutions with no metal added are plotted on the vertical axis of a graph, with the concentration of the known standard plotted on the horizontal axis. When the resulting line is extrapolated back to zero absorbance, the absolute value of the x-intercept gives the concentration of the unknown. Conventional spiking of samples is not used when the method of addition is used.

The results obtained by the method of addition compared to the direct method are shown in Table 6. Most of the results are for soluble metals because most insoluble concentrations were very low. The result of the addition method, versus the direct method of analysis, for insoluble copper shows a 16.6 percent deviation at the 0.06 mg/ℓ level. For the soluble metals, the greatest deviation is 13.6 percent for antimony.

TABLE 6. METALS BY DIRECT AND ADDITION METHOD

Metal	Sample	Soluble (S) or Insoluble (I)	Method, mg/ℓ		% Deviation from Average
			Direct	Addition	
Copper	008	S	0.14	0.16	6.7
	005	I	0.05	0.07	16.6
Zinc	007	S	0.10	0.12	9.1
	008	S	0.20	0.23	6.9
Lead	008	S	2.43	2.78	6.7
	009	S	0.87	0.90	1.7
Antimony	001	S	0.89	1.17	13.6
	006	S	17.9	17.3	1.7
Cadmium	004	S	0.08	0.08	0
	012	S	0.02	0.02	0
Chromium	002	S	0.09	0.10	5.3
	003	S	0.15	0.16	3.1
Nickel	006	S	0.94	1.04	5.3
	012	S	0.39	0.48	10.3

The mercury samples were spiked in the conventional manner instead of using the method of addition. Samples 006 and 003 for soluble mercury were spiked with 100 nanograms of mercury each with 105 percent and 108 percent recovery, respectively. Samples 006 and 003 for insoluble mercury were spiked with 100 nanograms of mercury. Recovery on these were 95 and 105 percent, respectively.

Duplicate analyses were run for all metals, except mercury, and these data are shown in Table 7. Excellent agreement was obtained for all metals except in Sample 006 for antimony which showed 15.7 percent deviation from the average result of 0.415 mg/ℓ. The rest of the values show less than 5 percent deviation from the average.

Summary of Quality Assurance Program

The quality assurance data discussed above for each compound reported, except pH values, were based on duplicate analyses, spikes, method of addition for metals, and mass spectrometer confirmation of gas chromatography analysis. These quality assurance data showed excellent results for duplicate runs, spikes, the method of addition versus direct method for metals and GC/MS confirmations.

The recovery of three spikes for the phenol analysis showed the greatest range of deviation at recoveries of 80.0, 90.4, and 115 percent of the amount added. The largest percent deviation from the average for the metal analysis was 16.6 percent for the insoluble copper and 13.6 percent for soluble antimony. These are good reproducibilities at these low levels using two different methods of analysis.

TABLE 7. DUPLICATE ANALYSES FOR METALS

Metal	Sample	Soluble, mg/ℓ		Insoluble, mg/ℓ	
		Run 1	Run 2	Run 1	Run 2
Copper	003	0.08	0.08	<0.01	<0.01
	006	1.82	1.75	<0.01	<0.01
Zinc	003	0.28	0.27	<0.01	<0.01
	006	7.75	7.50	0.03	0.03
Lead	003	1.84	1.81	<0.05	<0.05
	006	4.18	4.33	87.5	87.5
Antimony	003	<0.33	<0.33	<0.33	<0.33
	006	17.9	17.9	0.35	0.48
Cadmium	003	<0.01	<0.01	<0.01	<0.01
	006	3.03	2.98	<0.01	<0.01
Chromium	003	0.15	0.14	<0.01	<0.01
	006	0.41	0.41	0.02	0.02
Nickel	003	0.13	0.13	<0.04	<0.04
	006	0.94	0.94	<0.04	<0.04

Note: Mercury samples were spiked instead of direct duplicate analysis. See text for results.

SECTION 5

DISCUSSIONS OF EFFECTIVENESS OF LIME AND SETTLE TREATMENT FOR THE REMOVAL OF PRIORITY POLLUTANTS

WASTE LOADS PER 24-HOUR PERIODS

The analytical results and the average daily flow rates measured for the sampling period were used to calculate the waste loads of both the priority pollutants and the classical parameters for each of the waste streams sampled.

Priority Pollutant Loads

The mass flow of the priority pollutants entering and leaving the wastewater treatment plant daily are given in Table 8. Since benzene and cyanide concentrations were below detection limits, they were assumed to be absent and were not included in the loading calculations. Whenever concentrations of pollutants in a wastewater stream were found to be below detection limits, loadings were not calculated since such values would be meaningless. For example, phenols were found in sufficiently high concentration in the enclosure leachate (003), landfill leachate (004), and the industrial and automotive battery manufacture wastewater streams (008 and 012) to be measured, but because of dilution by the other streams, the concentration was below the detection limit in the influent and effluent. Concentrations of mercury and the insoluble forms of metals suggest similar behavior.

Classical Parameters Loads

The loads of pollutants given in Table 9 were selected as those parameters likely to be used for the development of effluent limitations for the secondary lead segment of the nonferrous metals point source category. Oil and grease was not one of these parameters, but probably would be one for the battery manufacturing or lead oxide manufacturing category. Since no samples were taken for oil and grease of the influent and effluent and no past history of such measurements being made at this plant exists, the data serve only to identify a loading for the two industries that must be removed by treatment. Sulfate is not one of the parameters for the secondary lead industry either. It was measured, however, to demonstrate its prevalence in the wastes from this type of manufacturing mix.

REMOVAL EFFICIENCIES

In Table 10, the waste load entering the treatment plant as the influent from the holding tank is compared with the load calculated from the sum of the

TABLE 8. WASTE LOAD OF PRIORITY POLLUTANTS IN 24-HOUR PERIOD, SECONDARY LOAD--BATTERY MANUFACTURE MIX

Waste Stream and Code	Priority Pollutant Load, kg/day[a][b]																	
	Phenols	Trichloro ethylene[a]	Copper		Zinc		Lead		Antimony		Cadmium		Chromium		Nickel		Mercury	
			Sol	Insol	Sol	Insol	Sol	Insol	Sol	Insol	Sol	Insol	Sol	Insol	Sol	Insol	Sol	Insol
Treatment Plant Effluent, 001	--	0.0028	0.062	--	0.078	0.016	0.202	0.218	1.383	--	0.047	--	0.140	--	0.233	--	--	--
Influent, 002	--	0.0052	0.250	--	0.906	--	3.907	14.376	1.250	--	0.172	--	0.141	--	0.219	--	--	0.0010
Enclosure Leachate, 003	0.0005	0.0045	0.006	--	0.044	--	0.136	--	--	--	--	--	0.011	--	0.098	--	--	--
Land Fill Leachate, 004	0.0010	0.0006	0.039	0.002	0.186	0.004	0.889	1.560	0.069	--	0.016	--	0.014	0.004	0.053	--	--	0.0001
Noncontact Cooling, 005	--	0.0001	0.001	0.007	0.042	0.007	0.043	0.513	--	--	0.006	--	0.006	--	0.015	--	--	--
Battery Breaker, 006	--	0.0002	0.126	--	0.531	0.002	0.293	6.145	1.257	0.029	0.086	--	0.029	0.001	0.066	--	0.00003	--
Process Water, 007	--	0.0068	0.010	--	0.104	--	0.167	0.052	--	--	--	--	0.031	--	--	--	--	--
Ind.Bat. Mfg, 008	0.0015	0.0009	0.043	--	0.061	--	0.736	1.297	--	--	--	--	0.015	--	--	--	--	0.0013
Auto Bat. Mfg, 009	--	0.0003	0.004	--	0.038	--	0.166	--	--	--	--	--	0.008	--	--	--	--	--
Lead Oxide Mfg, 010	--	0.0017	--	--	0.014	--	0.043	0.458	--	--	--	--	0.009	--	--	--	--	--
Remote Plant, 011	--	0.0005	0.003	0.004	0.005	0.010	0.054	1.252	--	--	0.002	--	0.004	--	0.010	0.012	--	0.00005
Auto Bat. Mfg Wash, 012	0.0095	0.0006	0.100	00	0.169	--	0.689	0.947	0.123	--	0.006	--	0.238	0.003	0.112	--	--	0.00009

(a) Benzene and cyanide concentration were below detection limits and not included in the waste load. Trichloroethylene was not one of the listed priority pollutants.

(b) Concentration of the pollutants was below detection limits in those waste streams marked with dash (--).

TABLE 9. WASTE LOAD OF CLASSICAL PARAMETERS IN 24-HOUR PERIOD[a]
Secondary Load - Battery Manufacture Mix

Waste Stream and Code	pH	Pollutant Load, kg/day[b]						
		Oil & Grease	Soluble Sulfate	TSS	Lead		Cadmium	
					Sol	Insol	Sol	Insol
Treatment Plant Effluent, 001	8.3		5.439	0.016	0.202	0.218	0.047	--
Influent, 002	1.4		7.344	0.078	3.907	14.376	0.172	--
Enclosure Leachate, 003	2.6		0.051	--	0.136	--	--	--
Land Fill Leachate, 004	4.5		0.632	0.016	0.889	1.560	0.016	--
Noncontact Cooling, 005	6.9		0.071	0.006	0.043	0.513	0.011	--
Battery Breaker, 006	0.6		2.814	0.014	0.293	6.145	0.086	--
Process Water, 007	7.6		0.052	--	0.167	0.052	--	--
Ind Bat Mfg, 008	2.9	0.133	1.809	0.015	0.736	1.397	--	--
Auto Bat Mfg, 009	1.4	--	0.076	--	0.166	--	--	--
Lead Oxide Mfg, 010	7.9	6.095	0.017	0.003	0.043	0.458	--	--
Remote Plant, 011	7.5	0.175	0.159	0.634	0.054	1.252	0.002	--
Auto Bat Mfg Wash, 012	0.7	0.459	10.678	0.040	0.689	0.947	0.006	--

(a) Classical parameters include the pollutants parameters selected for development of effluent limitations of the secondary lead segment of the nonferrous metals point source category, i.e., pH, TSS, As, Cd and Pb.

(b) Concentration of the pollutants were below detection limits in those waste streams marked with dash (--).

TABLE 10. COMPARISON OF WASTE LOAD IN TREATMENT PLANT INFLUENT TO LOAD MEASURED AT SUMPS AND THE REMOVAL EFFICIENCY BASED ON THE EFFLUENT WASTE LOAD[a]

Pollutant[b]		Waste Treatment Plant Influent kg/day	Sum of Pollutants from Sumps kg/day	Waste Treatment Plant Effluent kg/day	Removal Efficiency, % Based on Influent	Removal Efficiency, % Based on Σ Sumps
Phenol		--[c]	0.0125	--[c]	--	100
Trichloroethylene		0.0052	0.0162	0.0028	46	83
Copper:	Sol.	0.250	0.332	0.062	75	81
	Insol.	--	0.013	--	--	100
Zinc:	Sol.	0.906	1.194	0.078	91	93
	Insol.	--	0.023	0.016	0	30
Lead:	Sol.	3.907	3.216	0.202	95	94
	Insol.	14.376	12.224	0.218	98	98
Antimony:	Sol.	1.250	1.449	1.383	0	5
	Insol.	--	0.029	--	--	100
Cadmium:	Sol.	0.172	0.121	0.047	73	61
	Insol.	--	--	--	--	--
Chromium:	Sol.	0.141	0.365	0.140	0.7	62
	Insol.	--	0.008	--	--	100
Nickel:	Sol.	0.219	0.354	0.233	0	34
	Insol	--	0.012	--	--	100
Mercury:	Sol.	--	0.00003	--	--	100
	Insol.	0.001	0.0015	--	100	100
Oil & Grease		(d)	6.862	(d)	(d)	(d)
Sulfate		7.344	16.359 (5.681)[e]	5.439	26	33

(a) Retention time in holding tanks (144,100 g) is about 8.4 hours at collection rate of 410,580 g/day. Influent originates from holding tank into which sumps are discharged.
(b) Benzene and cyanide concentrations were below detection limit.
(c) Concentrations of the pollutants were below the detection limits for those marked with dash (--).
(d) Oil and grease not measured in influent or effluent.
(e) The value of 5.681 kg/day is the amount of sulfate less that contributed by the waste stream 012 (10.678 kg/day).

pollutant load in each waste stream sump. As mentioned earlier, because of the dilution of pollutants upon mixing of the waste streams in the holding tanks, their concentration ends up below the detection level (e.g., phenol and insoluble metals). There are discrepancies in the weight of soluble copper, antimony, chromium, nickel, and mercury which may be attributable to the dilution effect. The fact that the load of sulfate in stream 012 of 10.678 kg/day alone exceeds the load in the influent to the treatment plant of 7.344 kg/day suggests that some event in the production of automotive batteries contributed to this disparity. These variations also may be caused by the eight-hour retention time in the holding tanks, which would delay detection of gross variations in concentration. The holding tanks would also tend to average out extremes in concentration.

The efficiency for the removal of the priority pollutants by the technique of lime and settle (pH = 8.5) is also given in Table 9. The efficiency was calculated by the following method:

$$\frac{[(\text{kg/day})_{inf} - (\text{kg/day})_{eff}]}{(\text{kg/day})_{inf}} \times 100 = \text{Removal Efficiency, Percent.}$$

For comparison, the removal efficiency based on the load calculated from the sumps instead of the influent also is also presented.

Of the priority pollutants, lead, mercury, and zinc are removed 90 percent or better. Cadmium and copper are removed 70 percent or better. Efficiencies based on the summation of the sump loads are all better efficiencies based on the influent loadings except for lead and cadium. However, these values may have less meaning than the efficiencies calculated from the influent and effluent.

CONCLUSION

The lime and settle technique for the removal of metals at this secondary lead manufacturing plant is only 90 percent effective for zinc and lead, 70 percent effective for copper and cadmium, and ineffective for antimony and nickel. Benzene and cyanide are not present in detectable amounts, while phenol, although present in some streams, is reduced to below detection limits after treatment.

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APPENDIX

IDENTIFICATION LOG OF SAMPLES COLLECTED*

46-HR COMPOSITE SAMPLES

Secondary Lead Smelter Wastewater Streams**

March 21 (1655 hr) to March 23 (1508 hr), 1978

001^{ISCO}	Comp	Plant effluent - collected by ISCO auto sampler - programmed to collect 70 mℓ/20 mℓ (Note: ∿1 liter of effluent collected from 1655 to 0700 - expected ∿3 ℓ)
$001^{B\ ISCO}$	Blank	3 ℓ of blank water in a 1-gallon jug
001^{Manual}	Comp	Plant effluent collected manually 394 mℓ/2 hrs - 24 collection periods
002^{Drip}	Comp	Treatment plant influent collected by constant drip rate 3 mℓ/min
002^{Manual}	Comp	Treatment plant influent collected 394 mℓ/2 hrs - 24 collections periods (CP)
003^{Manual}	Comp	Creek enclosure leachate; collected 394 mℓ/2 hrs - 24 CP
004^{Manual}	Comp	Landfill dump leachate and smelter runoff - collected 394 mℓ/2 hrs - 24 CP
005^{Manual}	Comp	Blast furnace and smelter cooling water - 394 mℓ/2 hrs - 24 CP
006^{ISCO}	Comp	Battery breaker - acid and wash - ISCO auto sampler 70 mℓ/20 min (Note: Only 1 ℓ of sample collected in first 16 hours)
$006^{B\ ISCO}$	Comp	3 ℓ of blank water rinsed through auto sampler

(continued)

* From Battelle Record Book No. 33888

** Manual composite collected every 2 hours - total volume 10 ℓ (2.5 gal.); auto composite collected every 20 minutes - total volume 10 ℓ (2.5 gal).

006	Manual	Comp	Battery breaker - collected manually - 394 mℓ/2 hrs - 24 CP
007	Manual	Comp	Process water (city water) - 394 mℓ/2 hrs - 24 CP (Note: Spring water line was broken during sampling period.)

Battery Manufacturing Area*

March 21 (1655 hr) to March 23 (1608 hr), 1978

008	Manual	Comp	Industrial Battery Division - 394 mℓ/2 hrs - 24 CP
009	Manual	Comp	Automobile Battery Mfg., runoff and leachate - 394 mℓ/2 hrs - 24 CP
010	Manual	Comp	Automobile Battery Mfg., lead oxide manufacture - 394 mℓ/2 hrs - 24 CP
012	Manual	Comp	Automobile Battery Mfg., battery wash and rinse - 500 mℓ/2 hrs - 15 CP
011	Manual	Comp	Remote - Auto Battery Mfg. plant (treated with lime) 1500 mℓ/truck load - 5 truck loads
000		Blank	9.5 ℓ of blank water - BCL - Milli-Q Water

GRAB SAMPLES FOR CYANIDES**

Secondary Lead Smelter Wastewater Streams

March 21, 1978 (2100 - 2300)

001 CN	Wastewater treatment plant effluent
002 CN	Wastewater treatment plant influent
003 CN	Runoff and leachant surrounding creek enclosure
004 CN	Landfill leachant and smelter area runoff
005 CN	Blast furnace and lead ingot cooling water (city water, non-contact)
006 CN	Battery breaker sump
007 CN	Process water (city water)

* Manual composite collected every 2 hours - final volume 10 ℓ (2.5 gal).

** Each sample collected in a 1-ℓ amber polyethylene bottle, and preserved with 0.6 gm (1/4 level teaspoon) of asborbic acid and at least 2 mℓ of 10N NaOH. Final pH = 10.

Battery Manufacturing Area

March 21, 1978 (2100 - 2300)

008 CN	Industrial battery manufacturing
009 CN	Automobile battery manufacturing area leachate and runoff
010 CN	Automobile battery manufacturing lead oxide manufacturer
012 CN	Automobile battery manufacturing battery case washer
011 CN	Remote auto battery plant
000 CN	BCL's Milli-Q Water Blank

Secondary Lead Smelter Wastewater Streams

March 22, 1978 (1500 - 1600)

001 CN	Wastewater treatment plant effluent
002 CN	Wastewater treatment plant influent
003 CN	Runoff and leachate surrounding creek enclosure
004 CN	Landfill leachate and smelter area runoff
005 CN	Blast furnace and lead ingot cooling water (city water, non-contact)
006 CN	Battery breaker sump
007 CN	Process water (city water)

Battery Manufacturing Area

March 22, 1978 (1500 - 1600)

008 CN	Industrial battery manufacturing
009 CN	Automobile battery manufacturing area leachate and runoff
010 CN	Automobile battery manufacturing lead oxide manufacturer
012 CN	Automobile battery manufacturing battery case washer

011 CN	Remote auto battery plant
000 CN	BCL's Milli-Q Water Blank

GRAB SAMPLES FOR PHENOLS*

Secondary Lead Smelter Wastewater Streams

March 21, 1978 (2100 - 2330)

001 PH	Wastewater treatment plant effluent
002 PH	Wastewater treatment plant influent
003 PH	Runoff and leachate surrounding creek enclosure
004 PH	Landfill leachate and smelter area runoff
005 PH	Blast furnace and lead ingot cooling water (city water, non-contact)
006 PH	Battery breaker sump
007 PH	Process water (city water)

Battery Manufacturing Area

March 21, 1978 (2100 - 2330)

008 PH	Industrial battery manufacturing
009 PH	Automobile battery manufacturing area leachate and runoff
010 PH	Automobile battery manufacturing lead oxide manufacturer
012 PH	Automobile battery manufacturing battery case washer
011 PH	Remote auto battery plant
000 PH	BCL's Milli-Q Water Blank

Secondary Lead Smelter Wastewater Streams

March 22, 1978 (1500 - 1600)

001 PH	Wastewater treatment plant effluent

* Each sample collected in a 1 ℓ glass bottle and preserved with 2 mℓ H_2SO_4 (conc.), if pH was greater than 4.

002 PH	Wastewater treatment plant influent
003 PH	Runoff and leachate surrounding creek enclosure
004 PH	Landfill leachate and smelter area runoff
005 PH	Blast furnace and lead ingot cooling water (city water, non-contact)
006 PH	Battery breaker sump
007 PH	Process water (city water)

Battery Manufacturing Area

March 22, 1978 (1500 - 1600)

008 PH	Industrial battery manufacturing
009 PH	Automobile battery manufacturing area leachate and runoff
010 PH	Automobile battery manufacturing lead oxide manufacturer
012 PH	Automobile battery manufacturing battery case washer
011 PH	Remote auto battery plant
000 PH	BCL's Milli-Q Water Blank

GRAB SAMPLES FOR ORGANICS*

Secondary Lead Smelter Wastewater Streams

March 21, 1978 (2100 - 2330)

001 OR	Wastewater treatment plant effluent
002 OR	Wastewater treatment plant influent
003 OR	Runoff and leachate surrounding creek enclosure
004 OR	Landfill leachate and smelter area runoff
005 OR	Blast furnace and lead ingot cooling water (city water, non-contact)
006 OR	Battery breaker sump

* Samples collected in an 8-oz. glass bottle filled with a Teflon/silicone septa. Extra caution was taken to eliminate entrapped air bubbles at septa.

007 OR	Process water (city water)

Battery Manufacturing Area

March 21, 1978 (2100 - 2330)

008 OR	Industrial battery manufacturing
009 OR	Automobile battery manufacturing area leachate and runoff
010 OR	Automobile battery manufacturing lead oxide manufacturer
012 OR	Automobile battery manufacturing battery case washer
011 OR	Remote auto battery plant
000 OR	BCL's Milli-Q Water Blank

Secondary Lead Smelter Wastewater Streams

March 22, 1978 (1500 - 1600)

001 OR	Wastewater treatment plant effluent
002 OR	Wastewater treatment plant influent
003 OR	Runoff and leachate surrounding creek enclosure
004 OR	Landfill leachate and smelter area runoff
005 OR	Blast furnace and lead ingot cooling water (city water, non-contact)
006 OR	Battery breaker sump
007 OR	Process water (city water)

Battery Manufacturing Area

March 22, 1978 (1500 - 1600)

008 OR	Industrial battery manufacturing
009 OR	Automobile battery manufacturing area leachate and runoff
010 OR	Automobile battery manufacturing lead oxide manufacturer

012 OR	Automobile battery manufacturing battery case washer
011 OR	Remote auto battery plant
000 OR	BCL's Milli-Q Water Blank

GRAB SAMPLES FOR OIL AND GREASE*

Secondary Lead Smelter Wastewater Streams**

March 21, 1978 (2100 - 2330)

001 O&G	Wastewater treatment plant effluent
002 O&G	Wastewater treatment plant influent
003 O&G	Runoff and leachate surrounding creek enclosure
004 O&G	Landfill leachate and smelter area runoff
005 O&G	Blast furnace and lead ingot cooling water (city water, non-contact)
006 O&G	Battery breaker sump
007 O&G	Process water (city water)

Battery Manufacturing Area

March 21, 1978 (2100 - 2330)

008 O&G	Industrial battery manufacturing
009 O&G	Automobile battery manufacturing area leachate and runoff
010 O&G	Automobile battery manufacturing lead oxide manufacturer
012 O&G	Automobile battery manufacturing battery case washer
011 O&G	Remote auto battery plant
000 O&G	BCL's Milli-Q Water Blank

Secondary Lead Smelter Wastewater Streams**

March 22, 1978 (1500 - 1600)

001 O&G	Wastewater treatment plant effluent

* Each sample bottle contained 2 mℓ H_2SO_4 (conc.), before sample was collected.
** No special samples collected for this group.

002 O&G	Wastewater treatment plant influent
003 O&G	Runoff and leachate surrounding creek enclosure
004 O&G	Landfill leachate and smelter area runoff
005 O&G	Blast furnace and lead ingot cooling water (city water, non-contact)
006 O&G	Battery breaker sump
007 O&G	Process water (city water)

Battery Manufacturing Area

March 22, 1978 (1500 - 1600)

008 O&G	Industrial battery manufacturing
009 O&G	Automobile battery manufacturing area leachate and runoff
010 O&G	Automobile battery manufacturing lead oxide manufacturer
012 O&G	Automobile battery manufacturing battery case washer
011 O&G	Remote auto battery plant
000 O&G	BCL's Milli-Q Water Blank